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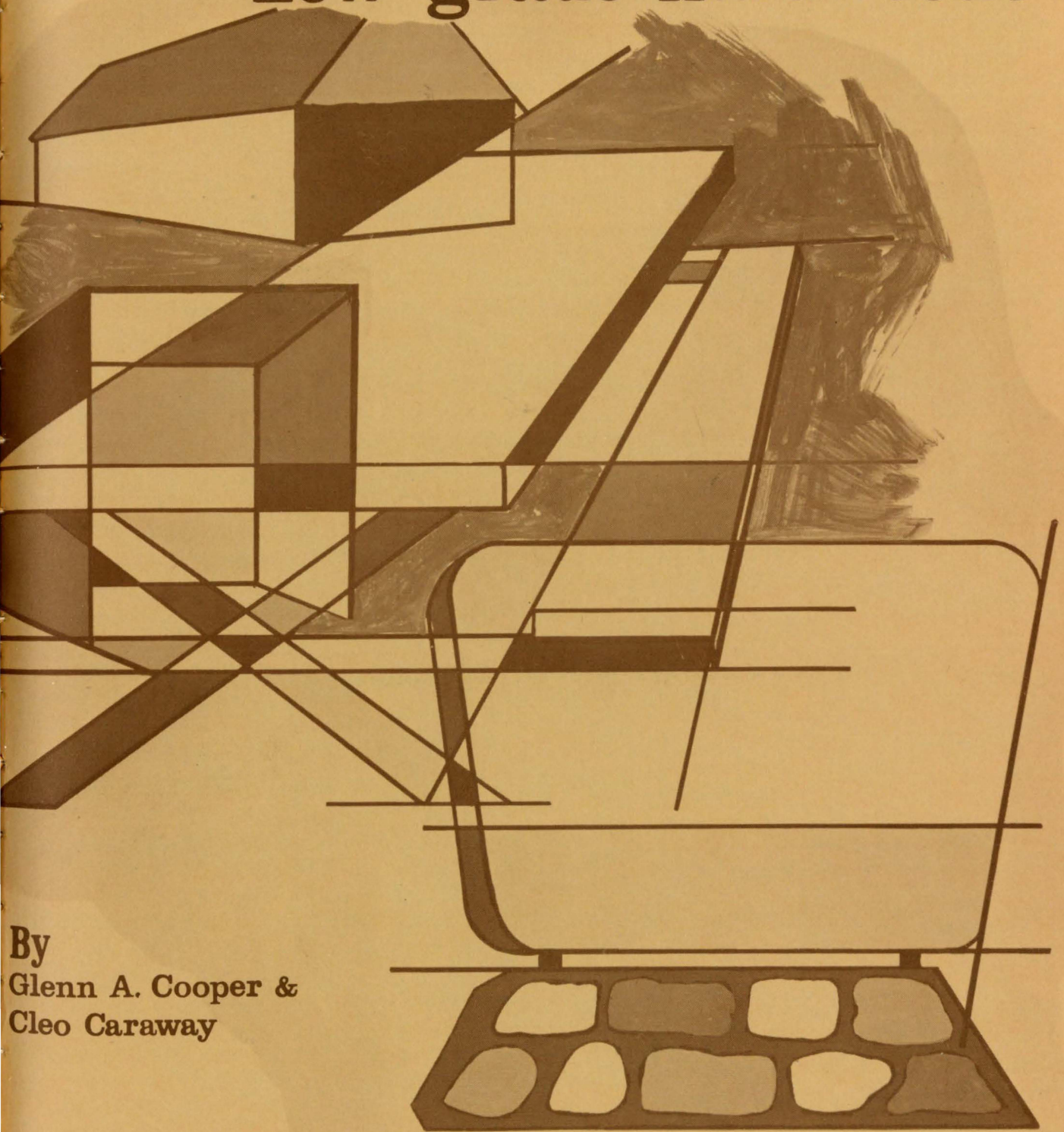
975

# Build Recreation Structures From Low-grade Hardwoods



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U.S. DEPARTMENT OF AGRICULTURE

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Movable benches . . . . . 6
Stationary benches . . . . . 6
A hardwood picnic shelter . . . . . 10
A hardwood rustic cabin . . . . . 12
Hickory stadium seat slats . . . . . 14
Hardwoods for rustic signs . . . . . 17
Summary . . . . . 19
Literature Cited . . . . . 19
Appendix . . . . . 20
Purchasing hardwoods . . . . . 20
Allowable defects . . . . . 20
Preservation and finishing . . . . . 21

## FOREWORD

From 1957 to 1966 wood technologists at the Forestry Sciences Laboratory tested the use of low-grade hardwood lumber for various products. One such group of products was recreation structures. These experiments showed that hardwoods had advantages over the traditional softwoods.

The many publications on recreation structures that were developed are now out of print, but public demand for the information has continued. To meet that demand, we have assembled all our information on hardwood recreation structures into a single paper. Plans, costs, and production data useful to small and large producers of recreation products are taken from earlier publications. All costs have been updated to 1974.

All the original works are cited. For those who want more detail, the original papers may be available in forestry school libraries and large libraries that serve as depositories for government publications. They are *not* available in their original form from any USDA Forest Service office.

## CONTENTS


Products for Recreation Areas . . . . . 1
Hardwood picnic tables . . . . . 1
A children's table . . . . . 5
Movable benches . . . . . 6
Stationary benches . . . . . 6
A hardwood picnic shelter . . . . . 10
A hardwood rustic cabin . . . . . 12
Hickory stadium seat slats . . . . . 14
Hardwoods for rustic signs . . . . . 17
Summary . . . . . 19
Literature Cited . . . . . 19
Appendix . . . . . 20
Purchasing hardwoods . . . . . 20
Allowable defects . . . . . 20
Preservation and finishing . . . . . 21

# BUILD RECREATION STRUCTURES FROM LOW-GRADE HARDWOODS

Glenn A. Cooper and Cleo Caraway

A variety of outdoor recreation structures, such as tables, benches, seats, cabins, shelters, and signs, can be made from No. 2 and No. 3 Common hardwood lumber. A large volume of material is available for these products. In the hardwood forests of the eastern United States about two-thirds of the sawtimber volume is in logs of the lowest grade; only about 13 percent is in top-grade logs. More than two-thirds of the lumber sawn from low-grade logs is No. 2 Common or poorer grade, and even the best grades of logs yield as much as 25 percent of their volume in these grades of lumber. This material is usually less expensive than Construction grade softwoods. Many products, traditionally made from Western softwoods or only high-grade clear wood, can be made as well or better and more economically from the No. 2 and No. 3 Common grades of hardwood lumber.

Some common misconceptions about hardwoods have limited their utilization. One fallacy is that hardwoods cannot be nailed. True, hardwoods resist nail penetration more than softer woods; however, in industry today human effort is minimized by portable, pneumatic nailers and staplers. Furthermore, many hardwoods can be successfully hand-nailed if the proper nails are used. Then too, many recreation structures should not be nailed: lag bolts, screws, and carriage bolts are much more appropriate.

Another fallacy is that hardwoods are not suitable for construction. This probably arises more from our common acceptance and the wide availability of softwoods for construction than from anything else. Hardwoods have been used successfully for framing, siding, and trusses--uses commonly filled by softwoods. Properly selected hardwoods are, in fact, usually stronger than the softwoods.

A third fallacy is that hardwoods do not dry well. Many hardwoods do take longer to dry than most softwoods, but modern kiln schedules permit hardwoods to be dried successfully. Furthermore, in many recreation structures, air seasoning is all that is necessary to bring the wood to the optimum moisture content, and minor seasoning defects are permissible in many products.

Hardwoods that are harder, heavier, and stronger than softwoods can be utilized to advantage in properly engineered products. The plans, designs, and production costs presented here were developed to put hardwoods to work advantageously. Everyone who wishes may utilize this information freely. It is presented in the hope that more products will be produced from the low-grade hardwoods and the pressure on higher priced grades and species of lumber will thereby be diminished.

## PRODUCTS FOR RECREATION AREAS

### Hardwood Picnic Tables (Cooper 1963a)

Standard National Forest picnic tables can be built from red oak and hickory lumber using conventional woodworking shop methods and equipment (see Appendix). No. 2 Common and No. 3A Common lumber of both species give satisfactory yields. An acceptable table containing minor wood defects that do not detract from utility or appearance can be built for about $53, plus indirect labor, machine, and overhead charges (figs.1 and 2). Complete production data on labor time and materials costs for tables made of each grade and species follow.

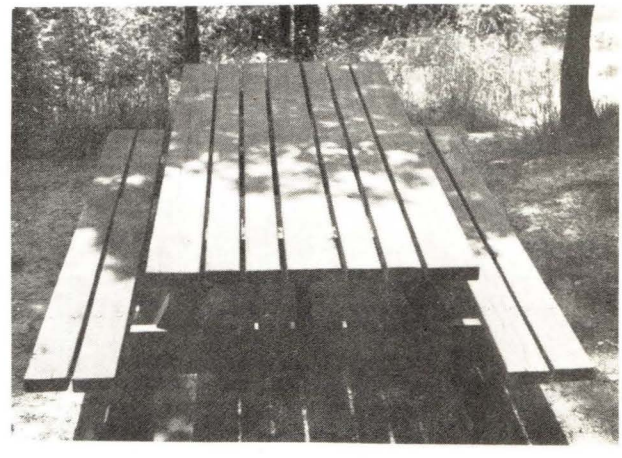
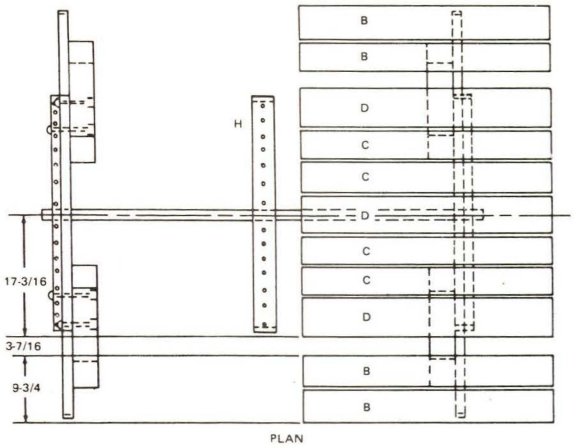
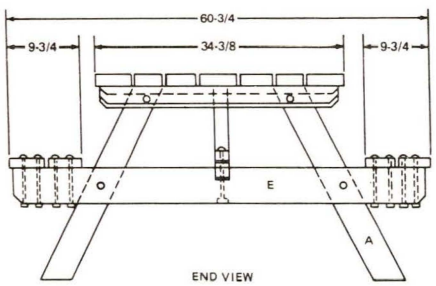


Figure 1.--*This 9-year-old, heavily used red oak table made from No. 3A Common lumber has been properly maintained and is in excellent condition.*

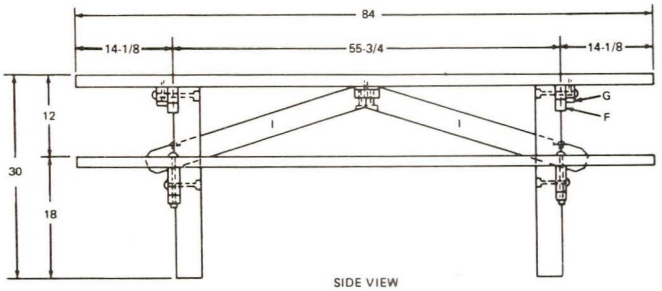
| MATERIAL LIST | | | | |
|---|---|---|---|---|
| No. | Size | Fin. | Name and use | Mark |
| 4 | 4"x4"x2'9½" | S4S | Legs | A |
| 4 | 2"x5"x7' | S4S | Seat planks | B |
| 4 | 2"x4"x7' | S4S | Top planks | C |
| 3 | 2"x6"x7' | S4S | Top planks | D |
| 2 | 2"x6"x5' | S4S | Seat cleats | E |
| 2 | 2"x4"x2'9½" | S4S | Top leg brace | F |
| 2 | 2"x3"x2'9½" | S4S | Top cleat | G |
| 1 | 2"x4"x2'9½" | S4S | Top center cleat | H |
| 2 | 2"x4"x2'9¼" | S4S | Braces | I |
| 2 | 3/8"x9" | Galv. | Carriage bolts-brace | |
| 16 | 3/8"x7½" | Galv. | Carriage bolts-seat | |
| 4 | 1/2"x6" | Galv. | Carriage bolts-top to legs | |
| 4 | 1/2"x4½" | Galv. | Carriage bolts-E to A | |
| 50 | 3/8"x3" | Galv. | Lag screws-G,H to C,D | |
| 68 | 3/8"x1" | Galv. | Washers-lag screws | |
| 8 | 1/2"x1½" | Galv. | Washers-bolts | |



PLAN



END VIEW



SIDE VIEW

SPECIFICATIONS

Use most economical, durable species available (see Wood Handbook, USDA Handbook 72), preferably heartwood cuts. Lumber shall be equivalent to West Coast Lumberman's Association "Construction" grade for Douglas fir. Lumber shall have an average moisture content, prior to treatment, of less than 20 percent.

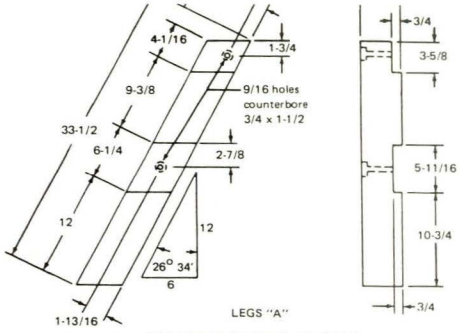
When cutting and boring is completed, the legs shall be given a preservative treatment by soaking for 48 hours, and all other parts for 7 hours, in a water repellent preservative certified as conforming to composition A (pentachlorophenol) of Federal Specification TT - W - 572, 'Wood Preservative, Water Repellent.' One brush coat of the Forest Products Laboratory Natural Finish, colored to Regional Standards, shall be applied after assembly. The interval between treating and applying the finish shall be such that the surface shall be free from waxy, greasy, oily, or crystalline deposits removable by rubbing with the fingers, free from any glossy film resembling that of varnish, and free from any easily detectable odor of treating solvent. If the only surface contamination is in the form of a few dry crystals that can readily be removed by brushing, finishing may be permitted if the surfaces are brushed clean.

Wood seat and top planks shall be installed with the heart side down.

Before mass production of this unit is started, a pilot model should be cut and assembled to assure proper dimension and fit.

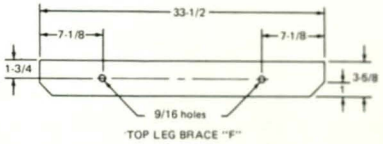
HARDWOOD LIGHT PLANK TABLE
developed by the
USDA FOREST SERVICE, NORTH CENTRAL FOREST EXPERIMENT STATION
and SOUTHERN ILLINOIS UNIVERSITY

Figure 2.--*Plan for Forest Service light-plank table. (Lumber sizes may vary by producer and amount of seasoning; if finished board widths and thicknesses different than those shown are used, the plan will have to be adjusted accordingly.)*

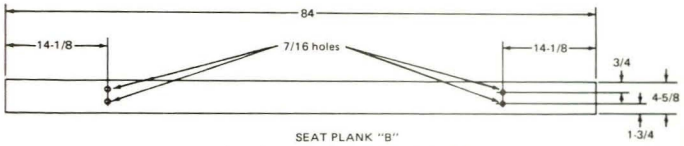



LEGS "A"

(make 2 rights [as shown], and 2 lefts)

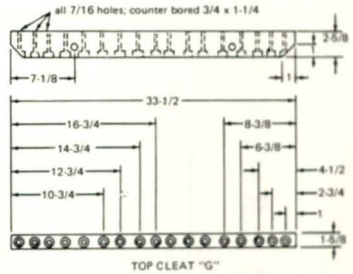



TOP LEG BRACE "F"

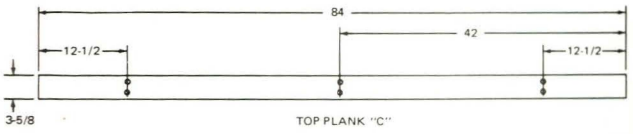



SEAT PLANK "B"

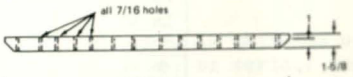
Note: Ease edges of seat and top planks 1/8".

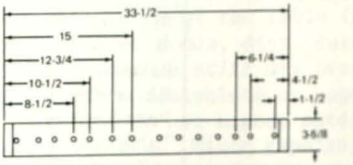



TOP CLEAT "G"

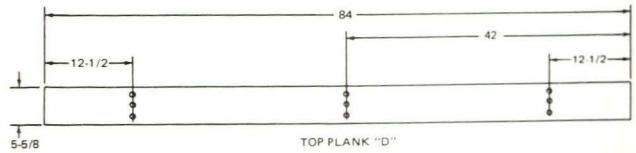



TOP PLANK "C"



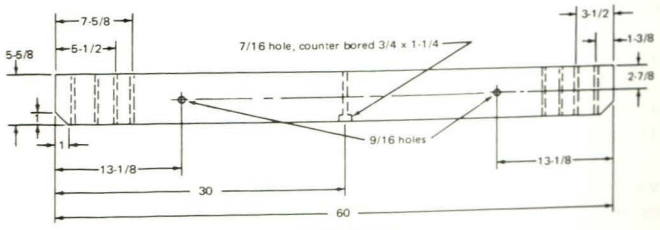




TOP CENTER CLEAT "H"

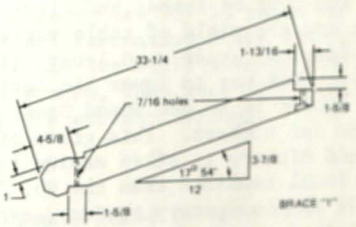



TOP PLANK "D"

Note: Lay out top planks in proper sequence with 3/8" space between planks, then using cleats G and H as predrilling templates, predrill 5/16" by 1" deep.




SEAT CLEAT "E"




BRACE "I"

Red oak and hickory lumber (No. 2 Common and No. 3A Common grades, 8/4-in.) in random widths 8 to 16 ft long is satisfactory, but the highest yield and best balance of parts for 7-ft tables will be obtained from 14-ft lumber. Legs can be

made from Sound Square Edge grade[1] timbers air-dried to less than 19 percent moisture content. Allowable defects (see Appendix) will of course be more numerous in parts produced from No. 3A Common lumber than from No. 2 Common lumber, but such defects do not detract from either the appearance or the utility of the finished tables.

The costs per table for materials and direct labor range from about $45 to $53 (table 1). Not included are indirect costs that could vary greatly by individual manufacturing plants: depreciation; maintenance of woodworking machinery; and plant, utilities, supervisory, and overhead costs.

or better factory-grade lumber. This makes it easier to obtain the longer cuttings for the tabletop and seat planks. The Sound Square Edge grade in random lengths costs about the same as No. 2 Common lumber of fixed length.

Cost of material other than lumber depends on the size and design of the table. This is true of hardware, finishing materials, and the preservative. Hardware costs average $9 per table for galvanized bolts, nuts, washers, and lag screws. The tables require an average of 0.2 gal of the natural-finish stain (USDA Forest Products Laboratory 1961) at a cost of about $1 per

Table 1.--*Average costs of materials and direct labor per table, 1974*

(In dollars)

| Materials | Grade and length of lumber | | | |
|---|---|---|---|---|
| | No. 2 Common | | No. 3A Common | |
| | Random length | 14-ft length | Random length | 14-ft length |
| **RED OAK** | | | | |
| 8/4-in. lumber[1] | 26 | 28 | 27 | 27 |
| 4- by 4-in. timbers[1] | 4 | 4 | 4 | 4 |
| Hardware | 9 | 9 | 9 | 9 |
| Finishing stain | 1 | 1 | 1 | 1 |
| Preservative | 1 | 1 | 1 | 1 |
| Labor[2] | 10 | 10 | 11 | 10 |
| Total | 51 | 53 | 53 | 52 |
| **HICKORY** | | | | |
| 8/4-in. lumber[1] | 22 | 20 | 22 | 20 |
| 4- by 4-in. timbers[1] | 3 | 3 | 3 | 3 |
| Hardware | 9 | 9 | 9 | 9 |
| Finishing stain | 1 | 1 | 1 | 1 |
| Preservative | 1 | 1 | 1 | 1 |
| Labor[2] | 11 | 11 | 11 | 11 |
| Total | 47 | 45 | 47 | 45 |

[1]Figures from table 2.
[2]At an average labor charge of $2.25/hr.

The cost of lumber and timbers per table and the yield of table parts varies with species, grade, and length (tables 1 and 2). One way to lower the cost of hardwood tables is to use Sound Square Edge lumber and timbers. This grade of thick oak and hickory is often easier to obtain from local sawmills than the No. 2 and No. 3A Common factory grades, and we have found that the Sound Square Edge grade contains some boards equivalent to No. 1 Common

[1]*These timbers may be supplied by local mill operators who define the Sound Square Edge grade as being free of wane, unsound defects, shake, and pith.*

table. The average cost of preservative is also about $1 per table (table 1).

At an average of $2.25/hr each for two laborers, the total cost of direct labor per table ranges from $10 to $11. In terms of labor, the cheapest lumber to convert to table parts is the No. 2 Common, 14-ft red oak and the most expensive is the No. 3A Common, random-length hickory.

All wood for tables should be seasoned to less than 20 percent moisture content before fabrication and preservative treatment. To produce tables efficiently, a shop should be equipped with a cut-off saw,

Table 2.--*Yield of table parts and cost of lumber and timbers, 1974*

| Grade, thickness, and length | Yield | Input required for 12 tables | Price per thousand board feet delivered | Cost for 12 tables | Cost per table[1] |
|---|---|---|---|---|---|
| | *Percent* | *Board feet* | *Dollars* | *Dollars* | *Dollars* |
| **RED OAK** | | | | | |
| No. 2 Common, 8/4-in., random-length lumber | 50 | 1,890 | 165 | 312 | 26 |
| No. 2 Common, 8/4-in., 14-ft-length lumber | 52 | 1,867 | 180 | 336 | 28 |
| No. 3A Common, 8/4-in., random-length lumber | 44 | 2,160 | 150 | 324 | 27 |
| No. 3A Common, 8/4-in., 14-ft-length lumber | 48 | 1,964 | 165 | 324 | 27 |
| Sound Square Edge, 4- by 4-in., 8 to 12 ft timbers | 75 | 270 | 175 | 48 | 4 |
| **HICKORY** | | | | | |
| No. 2 Common, 8/4-in., random-length lumber | 43 | 2,200 | 120 | 264 | 22 |
| No. 2 Common, 8/4-in., 14-ft-length lumber | 54 | 1,778 | 135 | 240 | 20 |
| No. 3A Common, 8/4-in., random-length lumber | 40 | 2,400 | 110 | 264 | 22 |
| No. 3A Common, 8/4-in., 14-ft-length lumber | 48 | 2,000 | 120 | 240 | 20 |
| Sound Square Edge, 4- by 4-in., 8 to 12 ft timbers | 75 | 270 | 135 | 36 | 3 |

[1]To determine the total cost per table, add the cost of the 8/4-in. lumber to the cost of the 4- by 4-in. timbers of the same species.

straight-line rip saw, jointer, surfacer, table saw, radial arm saw, bandsaw, and floor-type drill press.

Red oak and hickory are not naturally durable woods, so table parts should be preservatively treated after fabrication and before assembly (see Appendix). Good construction principles pay off in long service. Tables should be assembled, after predrilling for screws and bolts, so that seat and top planks are installed with the bark side up. The bark side is less likely to shell with alternate wetting and drying during exposure. Bolt heads should be driven flush with the boards, but crushing should be avoided. Crushed grain will eventually lead to loose bolts, debris collection under the bolt heads, and water collection and decay.

Hardwood picnic tables are easy to maintain, especially if kept in continuous shade. Penta-fortified water-repellent stain finish should last at least 2 years on shaded tables. Do not scrub with a strong detergent. Scrubbing lifts the finish, exposing the wood to extremes of wetting and drying, promotes serious checking, and ruins the appearance of the table (Cooper 1968). Remove spilled foods, dirt, dust, and bird droppings with a stiff dry brush. Most picnickers use a tablecloth or paper under their food and do not expect outdoor equipment to be sterile. Minor repairs, including tightening bolts and nuts, are usually needed every 2 years.

Hickory and red oak picnic tables tested under heavy use for 10 years on National Forest recreation areas have given good service and are still in good condition. Furthermore, they were more durable than comparable softwood tables.

## A Children's Table (Cooper 1964)

An attractive and sturdy picnic table for children can be made from hardwood lumber for $10 or less. Its two seats will comfortably accommodate four children, and it will not tip if weight becomes unbalanced between the two sides (figs. 3 and 4).

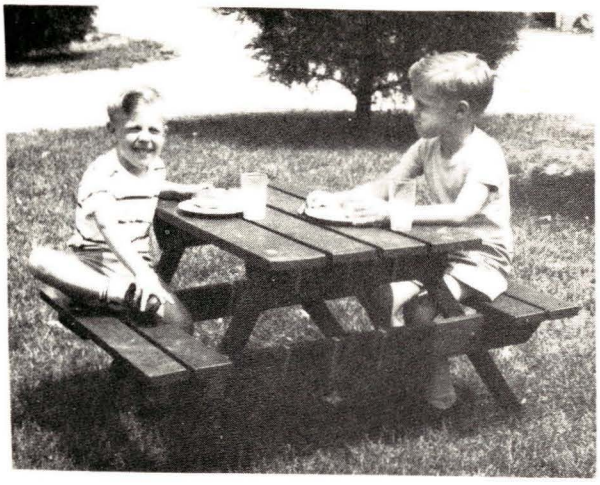


Figure 3.--*This red oak picnic table for children is unlikely to tip even if the seating becomes unbalanced.*

Hardwoods in the table resist marring and breakage.

The 36- by 45-in. table requires only 15 board feet of wood parts (fig. 4) made from air-seasoned, 1-in., No. 2 Common red oak or hickory lumber. The table parts are small, and sound knots can be included, permitting a 70-percent yield of parts. At $160 per thousand board feet, wood parts would cost less than $3.50 per table. Preservative, stain, hardware, and direct labor would cost about $6.20. This total direct cost of about $9.70 per table could be reduced in a commercial shop if the tables were mass-produced.

Preservative treatment of the table parts will prevent decay and insect damage and add years of life if tables are used outdoors. Parts should be cut to size and drilled and then treated by dipping for 5 min in a 5-percent solution of water-repellent pentachlorophenol preservative in mineral spirits.

If the table will be used inside, it can be finished with a stain, then lacquered or varnished. Stain can be omitted if a natural wood color is desired.

## Movable Benches

A comfortable bench 5 ft long (figs. 5 and 6) requires 41 board feet of wood parts cut from red oak or hickory 8/4-in., No. 2 Common, air-dried lumber (Cooper 1963b). This rough lumber costs about $165 per thousand board feet (1974). Assuming a 60-percent yield of usable cuttings, wood parts for this bench would cost $11.30. Benches can be built for less than $22 each for direct labor and all materials in a plant equipped to crosscut, rip, plane, and drill hardwood lumber.

The wood parts listed in the bill of materials (see plan and Appendix) can include sound defects such as stain, wormholes, and tight knots 1/4 in. in diameter or smaller. Normal surface checks are also permissible.

Completed parts should be treated with a water-repellent preservative (see Appendix). When the parts have dried, the bench can be assembled with ordinary handtools. All flat-grain planks and armrests should be installed with the bark side of the board upward to reduce splintering and shelling. After assembly, the bench should be coated with a natural finish penetrating stain, preferably a water-repellent preservative type with double-strength pigments (see Appendix). This stain does not form a film, hence the benches are easy to refinish.

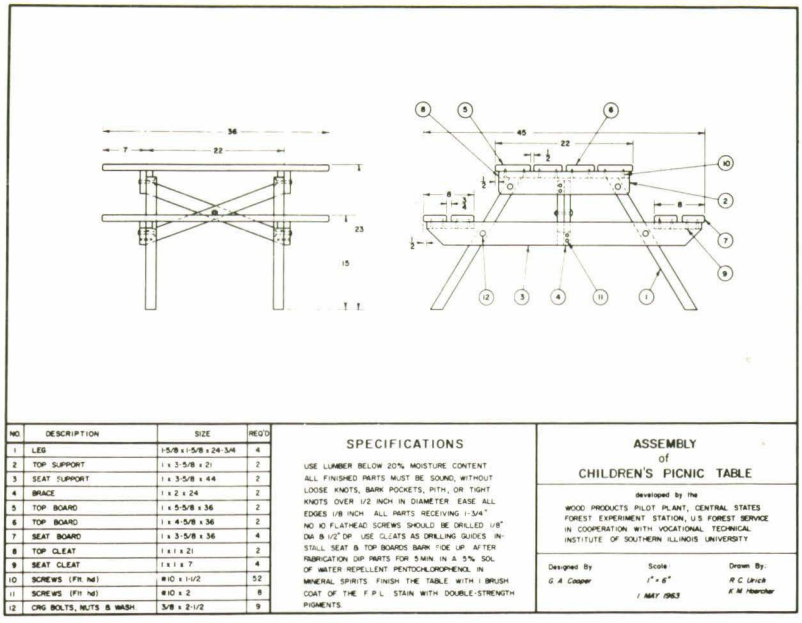
The bench will seat three persons comfortably. If a longer bench is needed, seat and back planks can be increased 18 in. in length to provide a four-seat bench. No alterations in the legs, armrests, or cleats would be necessary.

These benches can be easily produced in conjunction with large hardwood picnic tables. The part sizes are compatible and in many cases bench parts can be made from pieces left over from table production.

## Stationary Benches (Landt 1971)

Another style of bench, suitable in heavy-use areas or where a permanent location is desired, has a concrete base with 7-ft hardwood slats (figs. 7 and 8).

Hickory costs about the same as oak for practically defect-free bench slats. Even though the yield of slats from No. 2 Common hickory is less (39 percent) than red oak (54 percent) and the machining costs for hickory are greater, the lumber costs offset the differences and the per-slat cost for both woods is about $2.75




| NO. | DESCRIPTION | SIZE | REQ'D |
|---|---|---|---|
| 1 | LEG | 1-5/8 x 1-5/8 x 24-3/4 | 4 |
| 2 | TOP SUPPORT | 1 x 3-5/8 x 21 | 2 |
| 3 | SEAT SUPPORT | 1 x 3-5/8 x 44 | 2 |
| 4 | BRACE | 1 x 2 x 24 | 2 |
| 5 | TOP BOARD | 1 x 5-5/8 x 36 | 2 |
| 6 | TOP BOARD | 1 x 4-5/8 x 36 | 2 |
| 7 | SEAT BOARD | 1 x 3-5/8 x 36 | 4 |
| 8 | TOP CLEAT | 1 x 1 x 21 | 2 |
| 9 | SEAT CLEAT | 1 x 1 x 7 | 4 |
| 10 | SCREWS (FH hd) | #10 x 1-1/2 | 52 |
| 11 | SCREWS (FH hd) | #10 x 2 | 8 |
| 12 | CRG BOLTS, NUTS & WASH. | 3/8 x 2-1/2 | 9 |

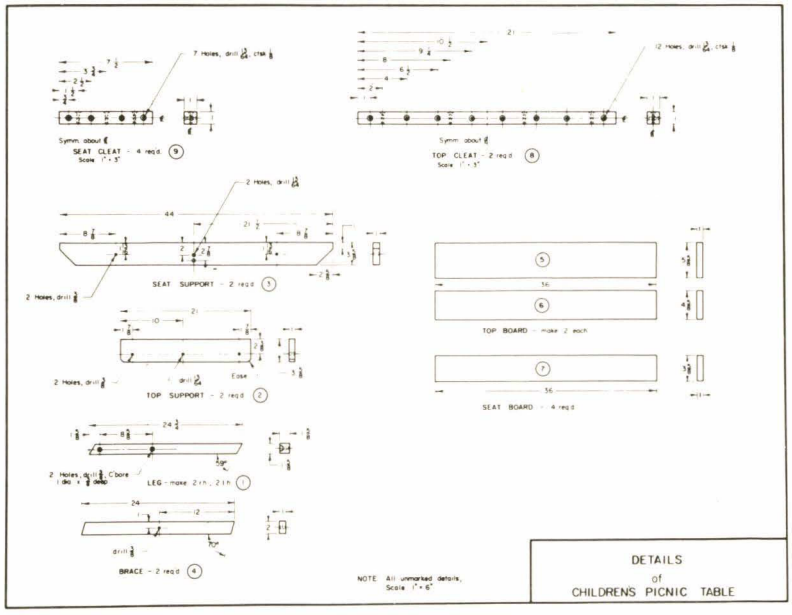
**SPECIFICATIONS**

USE LUMBER BELOW 20% MOISTURE CONTENT. ALL FINISHED PARTS MUST BE SOUND, WITHOUT LOOSE KNOTS, BARK POCKETS, PITH, OR TIGHT KNOTS OVER 1/2 INCH IN DIAMETER. EASE ALL EDGES 1/8 INCH. ALL PARTS RECEIVING 1-3/4" NO. 10 FLATHEAD SCREWS SHOULD BE DRILLED 1/8" DIA. & 1/2" DP. USE GUIDES AS DRILLING GUIDES. INSTALL SEAT & TOP BOARDS BARK SIDE UP. AFTER FABRICATION DIP PARTS FOR 5 MIN. IN A 5% SOL. OF WATER REPELLENT PENTOCHLOROPHENOL IN MINERAL SPIRITS. FINISH THE TABLE WITH 1 BRUSH COAT OF THE F.P.L. STAIN WITH DOUBLE-STRENGTH PIGMENTS.

**ASSEMBLY of CHILDREN'S PICNIC TABLE**

developed by the
WOOD PRODUCTS PILOT PLANT, CENTRAL STATES FOREST EXPERIMENT STATION, U.S. FOREST SERVICE IN COOPERATION WITH VOCATIONAL TECHNICAL INSTITUTE OF SOUTHERN ILLINOIS UNIVERSITY

Designed By: G. A. Cooper | Scale: 1" = 6" | Drawn By: R. C. Urich, K. M. Haerther
1 MAY 1963


7 Holes, drill
Symm. about ℄
SEAT CLEAT - 4 req'd. (9)
12 Holes, drill
TOP CLEAT - 2 req'd. (8)
2 Holes, drill
SEAT SUPPORT - 2 req'd. (3)
TOP SUPPORT - 2 req'd. (2)
Ease
LEG - make 2 rh, 2 lh (1)
BRACE - 2 req'd. (4)
TOP BOARD - make 2 each
SEAT BOARD - 4 req'd.
NOTE All unmarked details, Scale 1" = 6"

**DETAILS of CHILDRENS PICNIC TABLE**

Figure 4.--*Plan for Forest Service children's picnic table.*

(1974). This does not include indirect costs such as overhead and depreciation.

We recommend the concave bench design, lumber that has minor defects located only in the center of the slats, and soak-treating with a 5-percent pentachlorophenol water-repellent solution and brush retreating after 2 years of service.

Although both red oak and hickory, even when treated, check when exposed, they

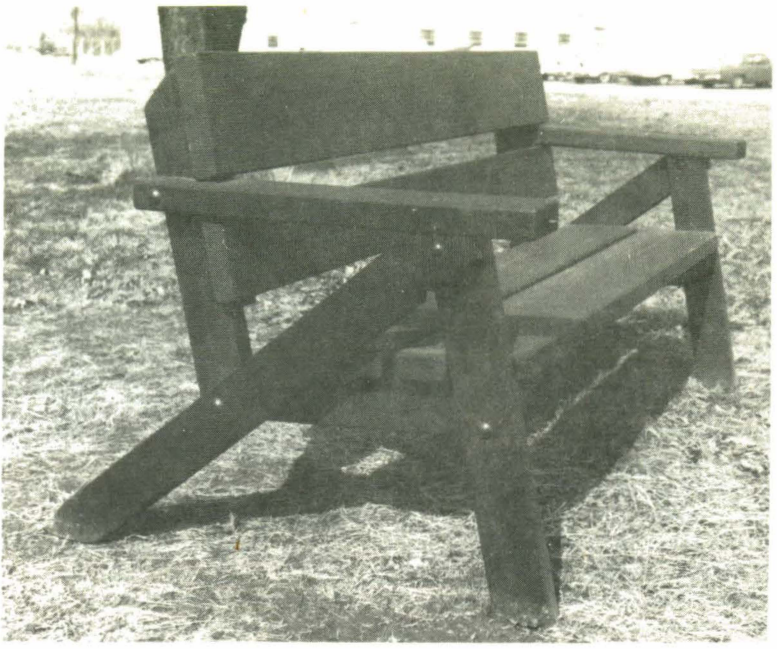


Figure 5.--*Because all the parts on this hickory bench are 1-3/4 in. thick and are joined with heavy bolts and screws, the bench is sturdy and can take rough service.*

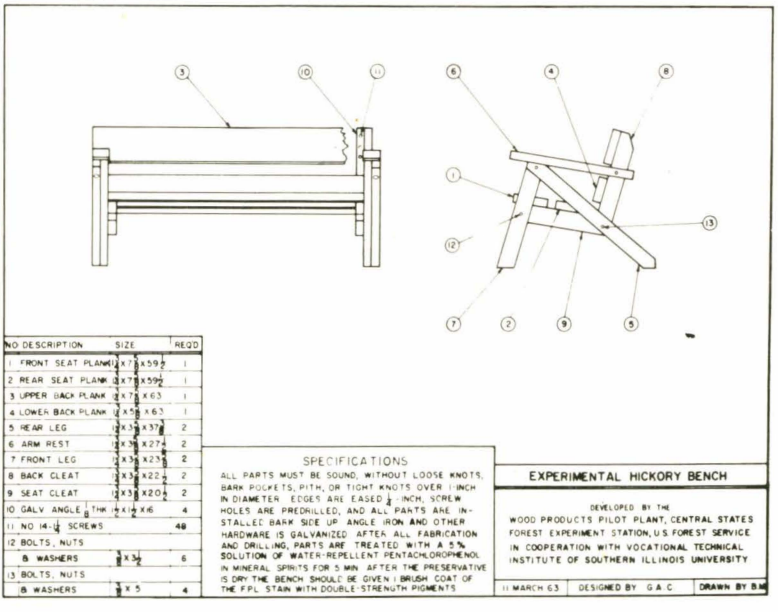
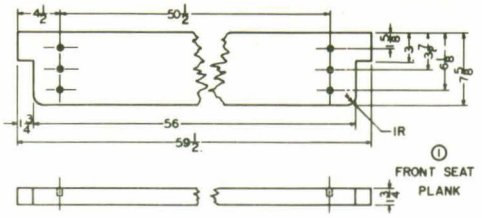
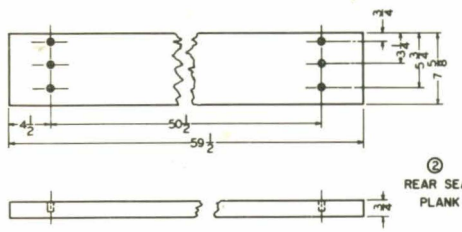

NO DESCRIPTION SIZE REQD
1 FRONT SEAT PLANK 1 X 7 1/2 X 59 1/2 1
2 REAR SEAT PLANK 1 X 7 1/2 X 59 1/2 1
3 UPPER BACK PLANK 1 X 7 1/2 X 63 1
4 LOWER BACK PLANK 1 X 5 1/2 X 63 1
5 REAR LEG 1 X 3 1/2 X 37 1/2 2
6 ARM REST 1 X 3 1/2 X 27 1/2 2
7 FRONT LEG 1 X 3 1/2 X 23 1/2 2
8 BACK CLEAT 1 X 3 1/2 X 22 1/2 2
9 SEAT CLEAT 1 X 3 1/2 X 20 1/2 2
10 GALV ANGLE 1/8 THK 1 1/2 X 1 1/2 X 6 4
11 NO 14-1 1/2 SCREWS 48
12 BOLTS, NUTS & WASHERS 3/8 X 3 1/2 6
13 BOLTS, NUTS & WASHERS 3/8 X 5 4
SPECIFICATIONS
ALL PARTS MUST BE SOUND, WITHOUT LOOSE KNOTS, BARK POCKETS, PITH, OR TIGHT KNOTS OVER 1 INCH IN DIAMETER. EDGES ARE EASED 1/4 INCH. SCREW HOLES ARE PREDRILLED, AND ALL PARTS ARE INSTALLED BARK SIDE UP. ANGLE IRON AND OTHER HARDWARE IS GALVANIZED. AFTER ALL FABRICATION AND DRILLING, PARTS ARE TREATED WITH A 5% SOLUTION OF WATER-REPELLENT PENTACHLOROPHENOL IN MINERAL SPIRITS FOR 5 MIN. AFTER THE PRESERVATIVE IS DRY THE BENCH SHOULD BE GIVEN 1 BRUSH COAT OF THE FPL STAIN WITH DOUBLE-STRENGTH PIGMENTS
EXPERIMENTAL HICKORY BENCH
DEVELOPED BY THE WOOD PRODUCTS PILOT PLANT, CENTRAL STATES FOREST EXPERIMENT STATION, U.S. FOREST SERVICE IN COOPERATION WITH VOCATIONAL TECHNICAL INSTITUTE OF SOUTHERN ILLINOIS UNIVERSITY
11 MARCH 63 DESIGNED BY G.A.C. DRAWN BY B.M.

Figure 6.--*Plan for Forest Service experimental hickory bench.*



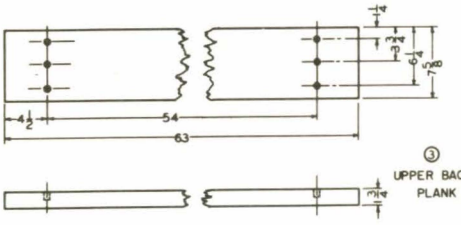

① FRONT SEAT PLANK

ALL HOLES ARE DRILLED $\frac{3}{16}$ DIAMETER $\frac{7}{8}$ DEEP FROM THE HEART SIDE.



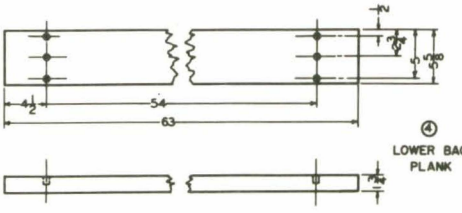

② REAR SEAT PLANK

ALL HOLES ARE DRILLED $\frac{3}{16}$ DIAMETER $\frac{7}{8}$ DEEP FROM THE HEART SIDE.



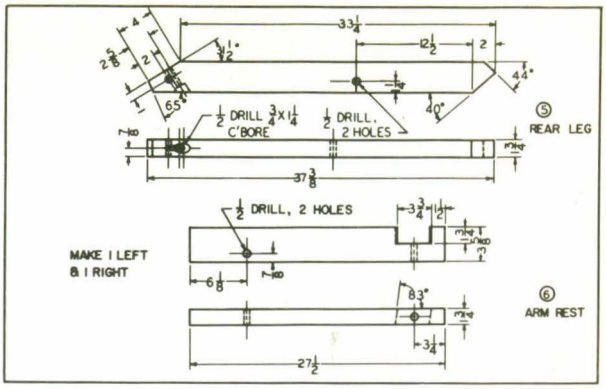

③ UPPER BACK PLANK

ALL HOLES ARE DRILLED $\frac{3}{16}$ DIAMETER $\frac{7}{8}$ DEEP, FROM THE HEART SIDE.




④ LOWER BACK PLANK

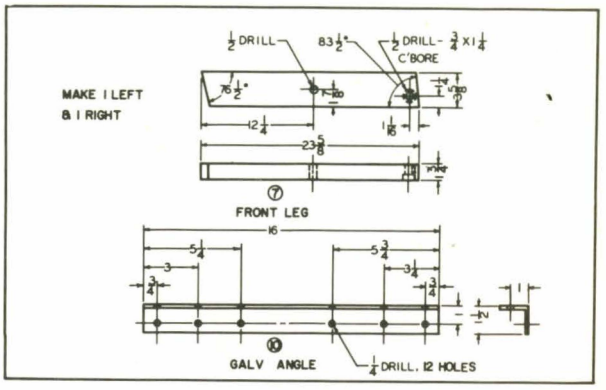
ALL HOLES ARE DRILLED $\frac{3}{16}$ DIAMETER $\frac{7}{8}$ DEEP, FROM THE HEART SIDE.




⑤ REAR LEG

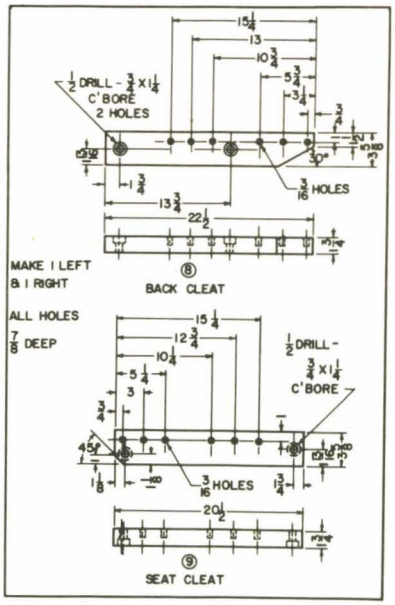



⑥ ARM REST




⑦ FRONT LEG




⑧ BACK CLEAT

⑨ SEAT CLEAT

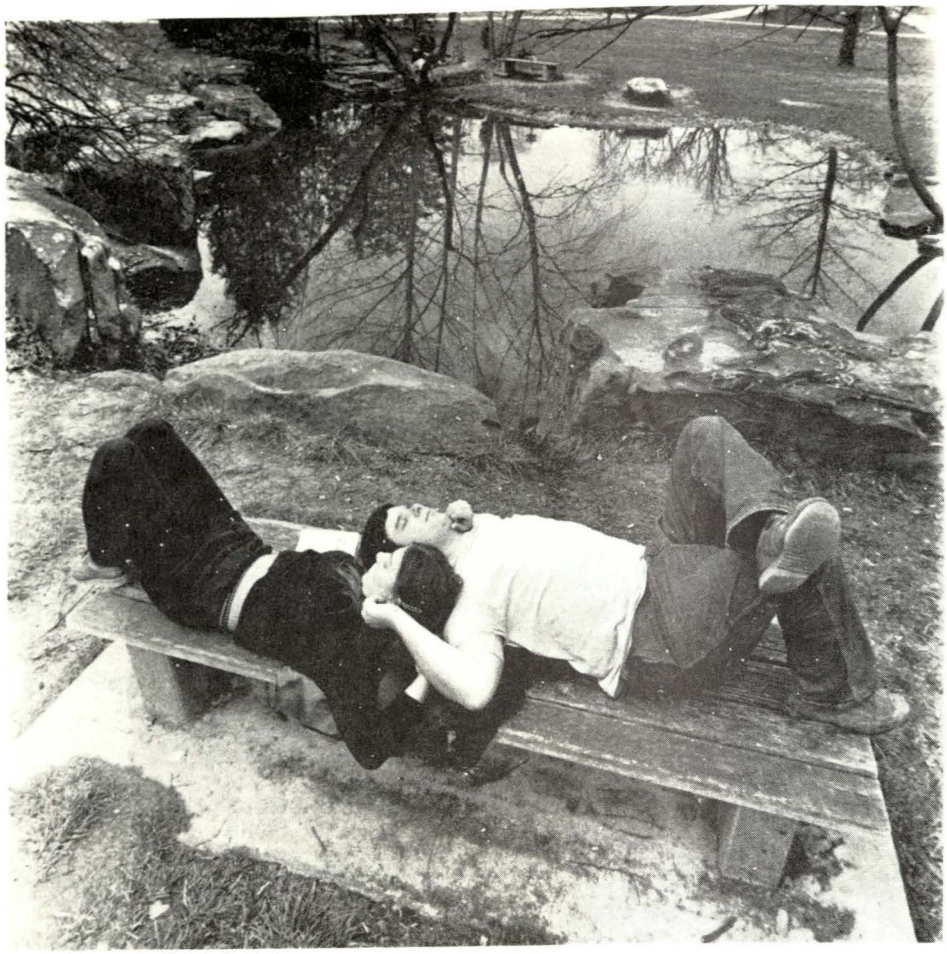


Figure 7.--*Forest Service wood-slat outdoor benches are used extensively at Southern Illinois University.*

weather with an attractive texture and become a mellow light to dark gray color. Untreated slats weather to a darker gray and mottled surface and are less attractive.

Defects in the lumber and location of the defects within the slats affect weathering resistance. Slats with few defects are more resistant to weathering than slats with many defects. Especially serious are defects such as knots located on the slat edge or end. Generally, sound, intergrown knots located near the middle of the slat do not detract from its use in the bench. Surfaces free of defects develop almost no splinters or rough areas.

Both red oak and hickory slats are more resistant to vandalism than those made from softwoods. This advantage, along with the characteristic weathering pattern that gives surfaces an attractive texture, makes red oak and hickory especially suitable for outdoor benches of this style.

## A Hardwood Picnic Shelter (Rice 1964)

Another outdoor facility that can be made from hardwood lumber is a picnic shelter. Our design for an attractive, sturdy, easily maintained shelter can also be used for a carport (fig. 9). The parts for this shelter can be fabricated either in a woodworking shop or on the site where it is to be erected.

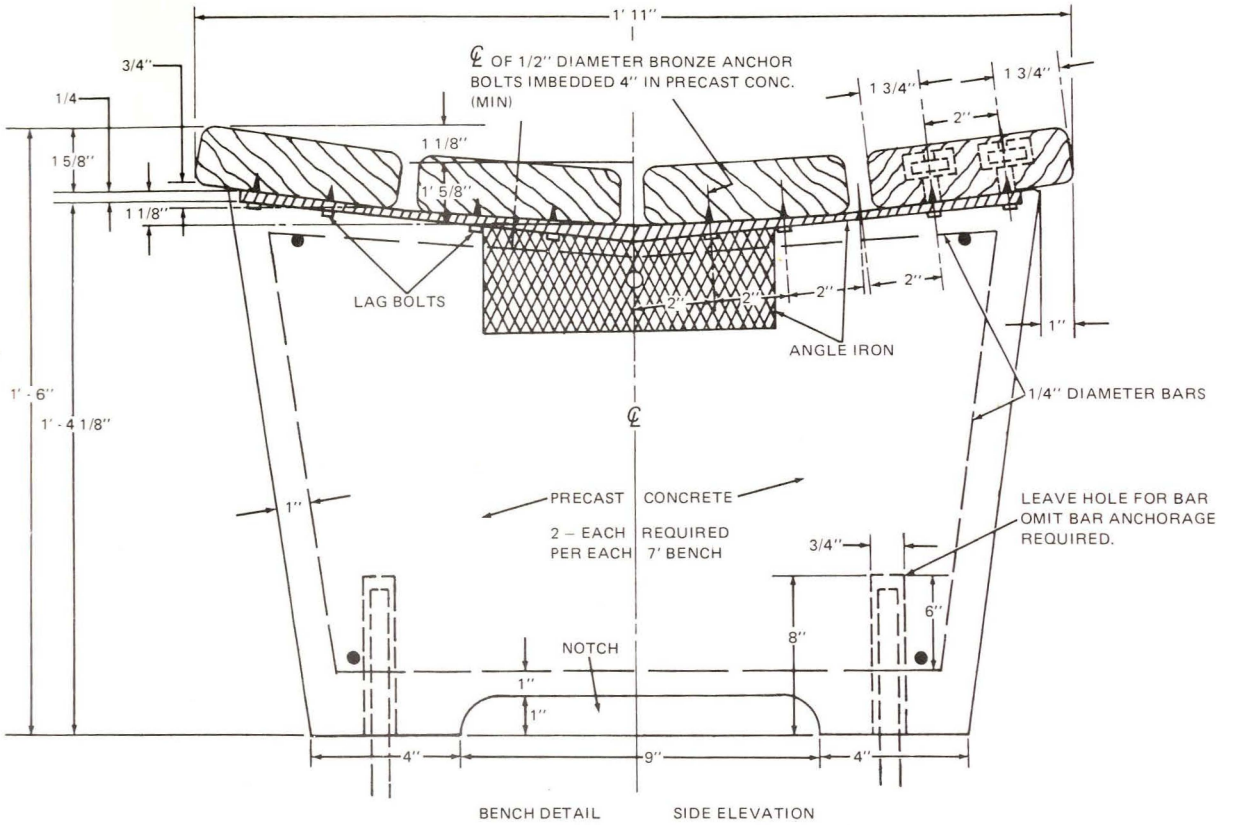



Figure 8.--*Campus bench using four 1 5/8- by 5 1/2- by 84-in. red oak or hickory slats on concrete legs. The slats are lag bolted from the bottom to an angle iron attached to concrete legs at each end of the bench. The concrete legs have a concave shape on the top so that each slat is pitched slightly from the horizontal plane. This prevents water from standing on the slat and thus helps in drying.*

Figure 9.--*A picnic shelter made of hardwood lumber.*

The plan is based on adaptations of the rigid-frame construction system. The studs and rafters are joined with nail-glued plywood gussets to form an arch. This system is simple, inexpensive, and provides clear spans.

In this 20- by 30-ft shelter, the rigid-frame design is used throughout the length of the building as well as across it, thereby eliminating the need for sidewall bracing. The roof is supported by four rigid, stud-rafter frames spaced 10 ft on center. For the eave beam and remainder of the column, the rigid-frame system is also used. The 34-ft-long eave beams are made by joining together two 12-ft pieces and one 10-ft piece. The columns are 6 ft 9 in. high, and when nailed to the stud-rafter units they form "T"-shaped members. Conventional ridge board and common rafter assemblies, with rafters spaced 2 ft on center, are used in each 10-ft bay. Sheathing and shingles complete the roof. The stud-rafter frames span 16 ft and a cantilever extension of the rafters provides a 2-ft roof overhang. Thus, the usable clear area within the shelter is 16 by 30 ft (480 $ft^2$) while the overall roofed area is 20 by 34 feet (680 $ft^2$).

The shelter requires approximately 800 board feet of nominal 2-in.-thick, No. 1 Common, oak or hickory lumber for structural members; 1,000 board feet of nominal 1-in.-thick mill run hardwood lumber, such as gum, cottonwood, or soft maple, for roof sheathing; and 80 $ft^2$ of 3/4-in.-thick exterior type Douglas-fir plywood for gussets (fig. 10). All the lumber should be air-dried to about 20 percent moisture content.

No. 1 Common lumber is usually free of defects that would be objectionable in the structural members. However, precautions must be taken so that knots or other defects do not appear on the edges of the rigid-frame columns, beams, and rafters, especially within 2 ft of the gusset-assembly points.

A wood preservative should be applied to the base of each stud and column before assembly to protect them from insect and decay damage. An effective method is to stand the studs and columns in drums or tubs of a 5-percent solution of pentachlorophenol in mineral spirits for 24 hr. The base of each member needs protection to 1 ft above the concrete pier line.

The length of the shelter can be extended indefinitely by adding bays as long as 10 ft each. But the roof will not safely span more than a 20-ft width unless rafters and columns are strengthened.

An attractive variation is to add a raked roof overhang at the ends of the shelter. This can be done by installing a 5-ft-long end ridge board, one pair of common rafters beyond the end rigid frame, and a pair of 10-ft, 11-1/4-in. end rafters. The longer end rafters are joined to the other rafters by bolts. Angle iron, 2 in. by 2 in. by 5 in. long, and bolts connect the end rafters to the ridge. To prevent sag in the raked overhang, place solid 2-by 6-in. bridging between the rafters. The bridging terminates at the outside of the end rigid frame.

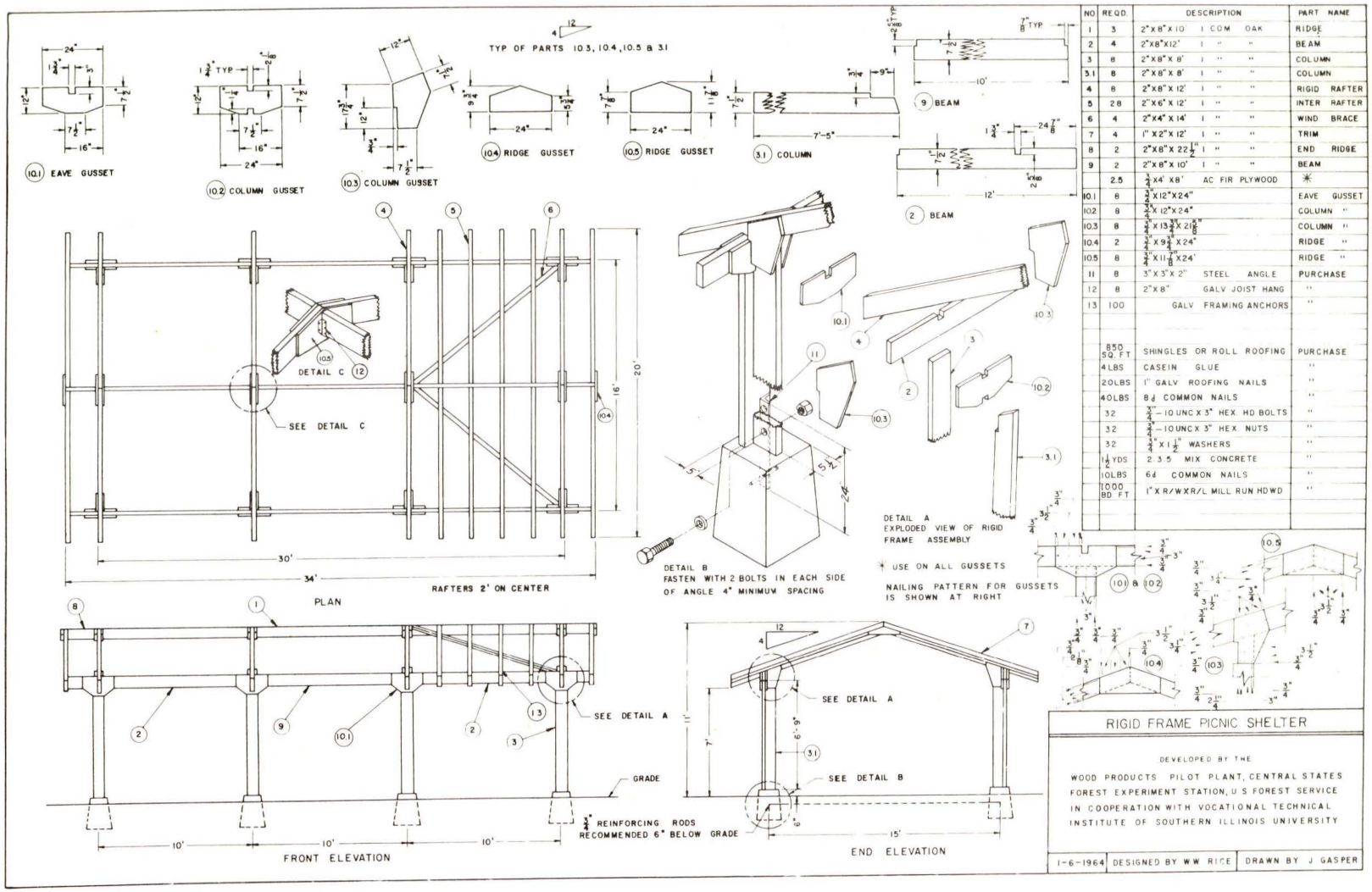
The shelter can be made in less than 200 man-hr using skilled labor at both shop and site. Savings in labor are possible if surfaced dimension stock and roof sheathing are purchased, rather than rough lumber which must be surfaced. Of course, labor savings here will be reflected in the higher material costs when buying presurfaced material.

We estimate that our shelter can be built for as little as $1,560, allowing $710 for materials (table 3) and $850 for labor. We assume that shelter parts are prefabricated in a well equipped shop and erected by skilled workers. These costs do not include machine operation, overhead, and profit.

## A Hardwood Rustic Cabin (Rice 1965)

This cabin was especially designed to be constructed from hardwood lumber and other materials available at any lumberyard (fig. 11).

A major feature of this cabin is rigid-frame construction, a type of assembly that is especially suitable for rustic buildings (fig. 12). The rigid-frame components (arches) are spaced 4 ft on center along the length of the building and wall-panel units are installed between the frames and in the end walls. The wall panels and the rigid frames can be installed on a conventional joist floor system, concrete piers, a foundation wall, or a concrete slab. Vertical board-and-batten siding can be used


TYP OF PARTS 10.3, 10.4, 10.5 & 3.1
10.1 EAVE GUSSET
10.2 COLUMN GUSSET
10.3 COLUMN GUSSET
10.4 RIDGE GUSSET
10.5 RIDGE GUSSET
3.1 COLUMN
9 BEAM
2 BEAM
DETAIL C
SEE DETAIL C
PLAN
RAFTERS 2' ON CENTER
DETAIL B
FASTEN WITH 2 BOLTS IN EACH SIDE OF ANGLE 4" MINIMUM SPACING
DETAIL A
EXPLODED VIEW OF RIGID FRAME ASSEMBLY
* USE ON ALL GUSSETS
NAILING PATTERN FOR GUSSETS IS SHOWN AT RIGHT
SEE DETAIL A
GRADE
REINFORCING RODS RECOMMENDED 6" BELOW GRADE
FRONT ELEVATION
SEE DETAIL A
SEE DETAIL B
END ELEVATION
RIGID FRAME PICNIC SHELTER
DEVELOPED BY THE
WOOD PRODUCTS PILOT PLANT, CENTRAL STATES FOREST EXPERIMENT STATION, U S FOREST SERVICE IN COOPERATION WITH VOCATIONAL TECHNICAL INSTITUTE OF SOUTHERN ILLINOIS UNIVERSITY
1-6-1964 DESIGNED BY WW RICE DRAWN BY J GASPER

| NO | REQD. | DESCRIPTION | PART NAME |
|---|---|---|---|
| 1 | 3 | 2"X8"X10' I COM OAK | RIDGE |
| 2 | 4 | 2"X8"X12' I " " | BEAM |
| 3 | 8 | 2"X8"X 8' I " " | COLUMN |
| 3.1 | 8 | 2"X8"X 8' I " " | COLUMN |
| 4 | 8 | 2"X8"X 12' I " " | RIGID RAFTER |
| 5 | 28 | 2"X6"X 12' I " " | INTER RAFTER |
| 6 | 4 | 2"X4"X 14' I " " | WIND BRACE |
| 7 | 4 | 1" X 2"X 12' I " " | TRIM |
| 8 | 2 | 2"X8"X 22½" I " " | END RIDGE |
| 9 | 2 | 2"X8"X 10' I " " | BEAM |
| | 2.5 | ¾ X 4' X 8' AC FIR PLYWOOD | * |
| 10.1 | 8 | ¾ X 12"X 24" | EAVE GUSSET |
| 10.2 | 8 | ¾ X 12"X 24" | COLUMN " |
| 10.3 | 8 | ¾ X 13¾ X 21⅝" | COLUMN " |
| 10.4 | 2 | ¾ X 9½ X 24" | RIDGE " |
| 10.5 | 8 | ¾ X 11 7/8" X 24" | RIDGE " |
| 11 | 8 | 3" X 3" X 2" STEEL ANGLE | PURCHASE |
| 12 | 8 | 2"X 8" GALV JOIST HANG | " |
| 13 | 100 | GALV FRAMING ANCHORS | " |
| | 850 SQ. FT | SHINGLES OR ROLL ROOFING | PURCHASE |
| | 4 LBS | CASEIN GLUE | " |
| | 20 LBS | 1" GALV ROOFING NAILS | " |
| | 40 LBS | 8d COMMON NAILS | " |
| | 32 | ¾"-10 UNC X 3" HEX HD BOLTS | " |
| | 32 | ¾"-10 UNC X 3" HEX NUTS | " |
| | 32 | ¾" X 1½" WASHERS | " |
| | ½ YDS | 2.3.5 MIX CONCRETE | " |
| | 10 LBS | 6d COMMON NAILS | " |
| | 1000 BD FT | 1" X R/WXR/L MILL RUN HDWD | " |

Figure 10.--*Plan for a Forest Service rigid-frame picnic shelter.*

Table 3.--*Material cost for a 20- by 34-ft hardwood picnic shelter, 1974*

| Item | Amount | Cost |
|---|---|---|
| | | *Dollars* |
| 8/4 Framing lumber | 800 fbm | 224 |
| 4/4 Sheathing lumber | 1,000 fbm | 160 |
| 3/4 Plywood | 80 $ft^2$ | 32 |
| Asphalt shingles | 7-2/3 squares | 100 |
| Framing anchors and nails | | 64 |
| Concrete | 1-1/2 yd | 35 |
| Bolts, steel parts | | 40 |
| Wood preservative | 20 gal | 20 |
| Stain | 5 gal | 35 |
| Total | | 710 |

on the exterior (Cooper 1967), and the roof can be sheathed and shingled.

The rigid frames span 17 ft and, by a cantilever extension of the rafters, provide a 2-ft overhang for the roof. Usable clear area within the cabin is 16 by 20 ft (320 $ft^2$) with an 8- by 17-ft (136 $ft^2$) open porch at one end.

The cabin requires approximately 2,500 board feet of nominal 2-in.-thick, Sound Square Edge grade, oak or hickory lumber for studs and rafters; 1,000 board feet of nominal 1-in.-thick, No. 2A Common, yellow-poplar lumber for siding; 450 board feet of 25/32-in.-thick tongue-and-groove oak flooring; and 600 $ft^2$ of 3/8-in.- and 3/4-in.-thick Douglas-fir plywood for gussets and subflooring.

It is easy to vary the design of the cabin. For instance, it can be lengthened by adding 4-ft sections. The rigid frames can be made to span 20 ft in width (plus overhang) by lengthening the 2- by 6-in. rafters. Spans greater than 20 ft would require larger rigid-frame members.

The cabin can be made weathertight by installing glass windows in place of screens, closing in the ceiling and insulating the roof, and sheathing and insulating the side walls before applying the board-and-batten siding. Solid wood paneling or sheets of plywood, hardboard, or plasterboard paneling can be easily installed on the interior walls.

Figure 11.--*A rigid-frame cabin made from hardwood lumber.*

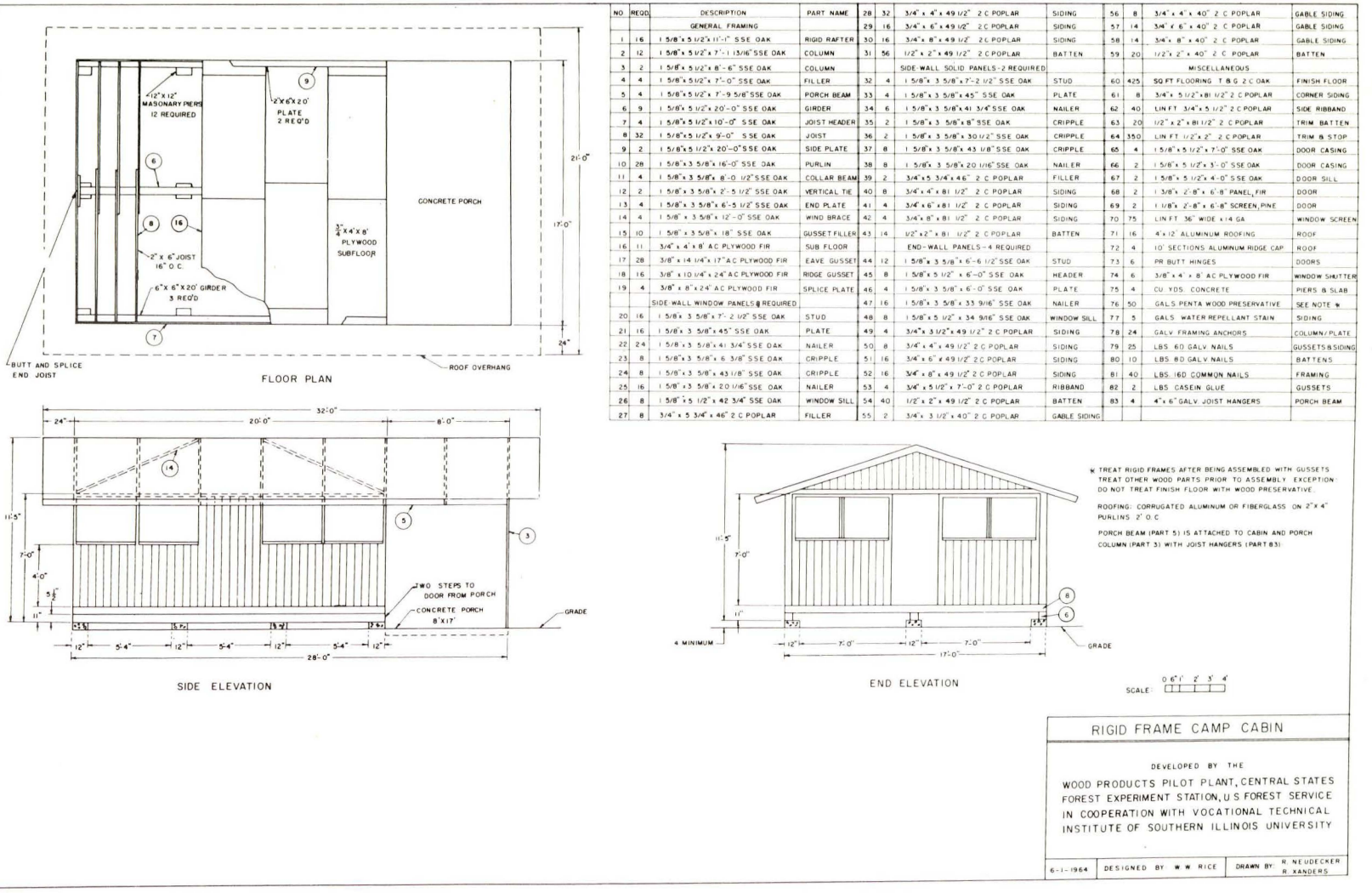
As designed, the cabin is one large room. However, partitions can be added to form closets and to screen kitchen and sanitary facilities. Plumbing for a kitchen and bathroom can be located wherever desired and installed whenever convenient if the cabin is built on piers or a foundation. Holes for water pipes and drains can be bored through the floor or sill plates without making structural changes in the framing. However, if the cabin is erected on a concrete slab, the plumbing should be in place before the slab is poured.

This cabin can be built for as little as $2,000 in labor and materials if parts are prefabricated in a well equipped shop and if the cabin is erected by skilled workers. Labor savings are possible if surfaced lumber is used, but at least part of these savings must be used to pay for the ready-to-use material. Siding should be rough on the weather face and dressed on the inner face. Rough lumber stock and siding will cost about $700.

Siding and framing parts should be preservatively treated to prevent insect damage and decay. Rough exterior faces of the siding should be finished with a water-repellent, penta-fortified stain (see Appendix).

## Hickory Stadium Seat Slats

Most slat-type and single-board stadium seats have been made from softwoods (Sesco and Kallio 1967); but hardwoods, particularly hickory, have proved equal or superior to softwoods (Micklewright 1960, Sesco and Dunmire 1967).




| NO | REQD | DESCRIPTION | PART NAME | 28 | 32 | 3/4" x 4" x 49 1/2" 2 C POPLAR | SIDING | 56 | 8 | 3/4" x 4" x 40" 2 C POPLAR | GABLE SIDING |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GENERAL FRAMING | | 29 | 16 | 3/4" x 6" x 49 1/2" 2C POPLAR | SIDING | 57 | 14 | 3/4" x 6" x 40" 2 C POPLAR | GABLE SIDING |
| 1 | 16 | 1 5/8" x 5 1/2" x 11'-1" SSE OAK | RIGID RAFTER | 30 | 16 | 3/4" x 8" x 49 1/2" 2C POPLAR | SIDING | 58 | 14 | 3/4" x 8" x 40" 2 C POPLAR | GABLE SIDING |
| 2 | 12 | 1 5/8" x 5 1/2" x 7'-1 13/16" SSE OAK | COLUMN | 31 | 56 | 1/2" x 2" x 49 1/2" 2 C POPLAR | BATTEN | 59 | 20 | 1/2" x 2" x 40" 2 C POPLAR | BATTEN |
| 3 | 2 | 1 5/8" x 5 1/2" x 8'-6" SSE OAK | COLUMN | | | SIDE-WALL SOLID PANELS-2 REQUIRED | | | | MISCELLANEOUS | |
| 4 | 4 | 1 5/8" x 5 1/2" x 7'-0" SSE OAK | FILLER | 32 | 4 | 1 5/8" x 3 5/8" x 7'-2 1/2" SSE OAK | STUD | 60 | 425 | SQ FT FLOORING T & G 2 C OAK | FINISH FLOOR |
| 5 | 4 | 1 5/8" x 5 1/2" x 7'-9 5/8" SSE OAK | PORCH BEAM | 33 | 4 | 1 5/8" x 3 5/8" x 45" S SE OAK | PLATE | 61 | 8 | 3/4" x 5 1/2" x 8' 1/2" 2 C POPLAR | CORNER SIDING |
| 6 | 9 | 1 5/8" x 5 1/2" x 20'-0" SSE OAK | GIRDER | 34 | 6 | 1 5/8" x 3 5/8" x 41 3/4" SSE OAK | NAILER | 62 | 40 | LIN FT 3/4" x 5 1/2" 2 C POPLAR | SIDE RIBBAND |
| 7 | 4 | 1 5/8" x 5 1/2" x 10'-0" S SE OAK | JOIST HEADER | 35 | 2 | 1 5/8" x 3 5/8" x 8" SSE OAK | CRIPPLE | 63 | 20 | 1/2" x 2" x 81 1/2" 2 C POPLAR | TRIM BATTEN |
| 8 | 32 | 1 5/8" x 5 1/2" x 9'-0" S SE OAK | JOIST | 36 | 2 | 1 5/8" x 3 5/8" x 30 1/2" SSE OAK | CRIPPLE | 64 | 350 | LIN FT 1/2" x 2" 2 C POPLAR | TRIM & STOP |
| 9 | 2 | 1 5/8" x 5 1/2" x 20'-0" S SE OAK | SIDE PLATE | 37 | 8 | 1 5/8" x 3 5/8" x 43 1/8" SSE OAK | CRIPPLE | 65 | 4 | 1 5/8" x 5 1/2" x 7'-0" SSE OAK | DOOR CASING |
| 10 | 28 | 1 5/8" x 3 5/8" x 16'-0" SSE OAK | PURLIN | 38 | 8 | 1 5/8" x 3 5/8" x 20 1/16" SSE OAK | NAILER | 66 | 2 | 1 5/8" x 5 1/2" x 3'-0" SSE OAK | DOOR CASING |
| 11 | 4 | 1 5/8" x 3 5/8" x 8'-0 1/2" SSE OAK | COLLAR BEAM | 39 | 2 | 3/4" x 5 3/4" x 46" 2 C POPLAR | FILLER | 67 | 2 | 1 5/8" x 5 1/2" x 4'-0" SSE OAK | DOOR SILL |
| 12 | 2 | 1 5/8" x 3 5/8" x 2'-5 1/2" SSE OAK | VERTICAL TIE | 40 | 8 | 3/4" x 4" x 81 1/2" 2 C POPLAR | SIDING | 68 | 2 | 1 3/8" x 2'-8" x 6'-8" PANEL, FIR | DOOR |
| 13 | 4 | 1 5/8" x 3 5/8" x 6'-5 1/2" SSE OAK | END PLATE | 41 | 4 | 3/4" x 6" x 81 1/2" 2 C POPLAR | SIDING | 69 | 2 | 1 1/8" x 2'-8" x 6'-8" SCREEN, PINE | DOOR |
| 14 | 4 | 1 5/8" x 3 5/8" x 12'-0" SSE OAK | WIND BRACE | 42 | 4 | 3/4" x 8" x 81 1/2" 2 C POPLAR | SIDING | 70 | 75 | LIN FT 36" WIDE x 14 GA | WINDOW SCREEN |
| 15 | 10 | 1 5/8" x 3 5/8" x 18" SSE OAK | GUSSET FILLER | 43 | 14 | 1/2" x 2" x 81 1/2" 2 C POPLAR | BATTEN | 71 | 16 | 4' x 12' ALUMINUM ROOFING | ROOF |
| 16 | 11 | 3/4" x 4' x 8' AC PLYWOOD FIR | SUB FLOOR | | | END-WALL PANELS-4 REQUIRED | | 72 | 4 | 10' SECTIONS ALUMINUM RIDGE CAP | ROOF |
| 17 | 28 | 3/8" x 14 1/4" x 17" AC PLYWOOD FIR | EAVE GUSSET | 44 | 12 | 1 5/8" x 3 5/8" x 6'-6 1/2" SSE OAK | STUD | 73 | 6 | PR BUTT HINGES | DOORS |
| 18 | 16 | 3/8" x 10 1/4" x 24" AC PLYWOOD FIR | RIDGE GUSSET | 45 | 8 | 1 5/8" x 5 1/2" x 6'-0" S SE OAK | HEADER | 74 | 6 | 3/8" x 4' x 8' AC PLYWOOD FIR | WINDOW SHUTTER |
| 19 | 4 | 3/8" x 8" x 24" AC PLYWOOD FIR | SPLICE PLATE | 46 | 4 | 1 5/8" x 3 5/8" x 6'-0" SSE OAK | PLATE | 75 | 4 | CU. YDS. CONCRETE | PIERS & SLAB |
| | | SIDE-WALL WINDOW PANELS 8 REQUIRED | | 47 | 16 | 1 5/8" x 3 5/8" x 33 9/16" SSE OAK | NAILER | 76 | 50 | GALS PENTA WOOD PRESERVATIVE | SEE NOTE * |
| 20 | 16 | 1 5/8" x 3 5/8" x 7'-2 1/2" SSE OAK | STUD | 48 | 8 | 1 5/8" x 5 1/2" x 34 9/16" SSE OAK | WINDOW SILL | 77 | 5 | GALS WATER REPELLANT STAIN | SIDING |
| 21 | 16 | 1 5/8" x 3 5/8" x 45" SSE OAK | PLATE | 49 | 4 | 3/4" x 3 1/2" x 49 1/2" 2 C POPLAR | SIDING | 78 | 24 | GALV FRAMING ANCHORS | COLUMN/PLATE |
| 22 | 24 | 1 5/8" x 3 5/8" x 4' 3/4" SSE OAK | NAILER | 50 | 8 | 3/4" x 4" x 49 1/2" 2 C POPLAR | SIDING | 79 | 25 | LBS 60 GALV NAILS | GUSSETS & SIDING |
| 23 | 8 | 1 5/8" x 3 5/8" x 6 3/8" SSE OAK | CRIPPLE | 51 | 16 | 3/4" x 6" x 49 1/2" 2 C POPLAR | SIDING | 80 | 10 | LBS 8D GALV NAILS | BATTENS |
| 24 | 8 | 1 5/8" x 3 5/8" x 43 1/8" SSE OAK | CRIPPLE | 52 | 16 | 3/4" x 8" x 49 1/2" 2 C POPLAR | SIDING | 81 | 40 | LBS 16D COMMON NAILS | FRAMING |
| 25 | 16 | 1 5/8" x 3 5/8" x 20 1/16" SSE OAK | NAILER | 53 | 4 | 3/4" x 5 1/2" x 7'-0" 2 C POPLAR | RIBBAND | 82 | 2 | LBS CASEIN GLUE | GUSSETS |
| 26 | 8 | 1 5/8" x 5 1/2" x 42 3/4" SSE OAK | WINDOW SILL | 54 | 40 | 1/2" x 2" x 49 1/2" 2 C POPLAR | BATTEN | 83 | 4 | 4" x 6" GALV JOIST HANGERS | PORCH BEAM |
| 27 | 8 | 3/4" x 5 3/4" x 46" 2 C POPLAR | FILLER | 55 | 2 | 3/4" x 3 1/2" x 40" 2 C POPLAR | GABLE SIDING | | | | |

* TREAT RIGID FRAMES AFTER BEING ASSEMBLED WITH GUSSETS TREAT OTHER WOOD PARTS PRIOR TO ASSEMBLY EXCEPTION: DO NOT TREAT FINISH FLOOR WITH WOOD PRESERVATIVE.

ROOFING: CORRUGATED ALUMINUM OR FIBERGLASS ON 2"X 4" PURLINS 2' O.C

PORCH BEAM (PART 5) IS ATTACHED TO CABIN AND PORCH COLUMN (PART 3) WITH JOIST HANGERS (PART 83)

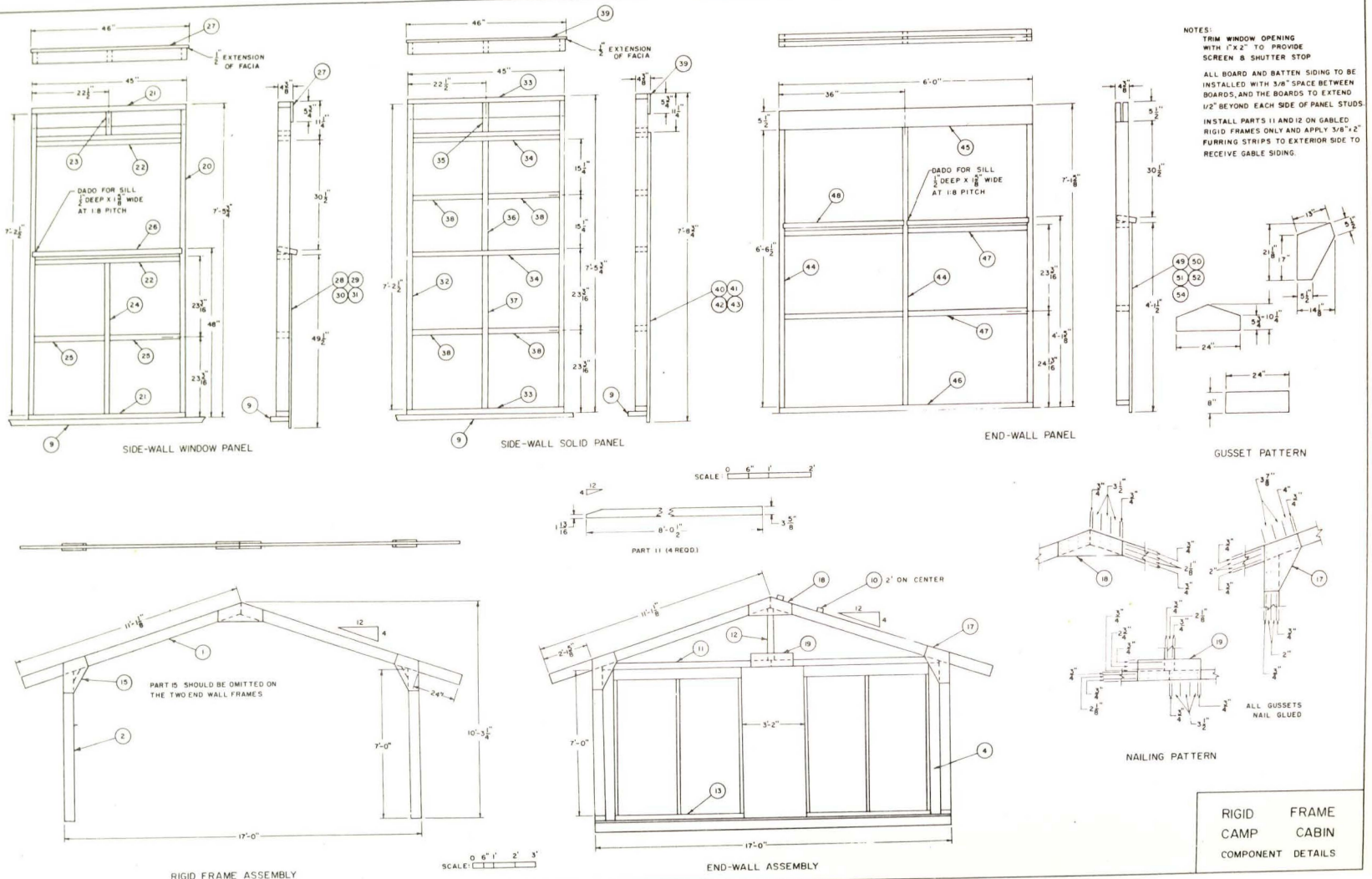
# RIGID FRAME CAMP CABIN

DEVELOPED BY THE

WOOD PRODUCTS PILOT PLANT, CENTRAL STATES FOREST EXPERIMENT STATION, U S FOREST SERVICE IN COOPERATION WITH VOCATIONAL TECHNICAL INSTITUTE OF SOUTHERN ILLINOIS UNIVERSITY

| 6-1-1964 | DESIGNED BY W.W. RICE | DRAWN BY R. NEUDECKER R. XANDERS |
|---|---|---|

Figure 12.--*Plan for Forest Service rigid-frame camp cabin.*


SIDE-WALL WINDOW PANEL
SIDE-WALL SOLID PANEL
END-WALL PANEL
GUSSET PATTERN
NOTES:
TRIM WINDOW OPENING WITH 1"x2" TO PROVIDE SCREEN & SHUTTER STOP
ALL BOARD AND BATTEN SIDING TO BE INSTALLED WITH 3/8" SPACE BETWEEN BOARDS, AND THE BOARDS TO EXTEND 1/2" BEYOND EACH SIDE OF PANEL STUDS.
INSTALL PARTS 11 AND 12 ON GABLED RIGID FRAMES ONLY AND APPLY 3/8"x2" FURRING STRIPS TO EXTERIOR SIDE TO RECEIVE GABLE SIDING.
PART 11 (4 REQD.)
RIGID FRAME ASSEMBLY
PART 15 SHOULD BE OMITTED ON THE TWO END WALL FRAMES
END-WALL ASSEMBLY
2' ON CENTER
NAILING PATTERN
ALL GUSSETS NAIL GLUED
RIGID FRAME CAMP CABIN
COMPONENT DETAILS

Hickory seat slats are strong, look good, and are durable when treated with a preservative. Furthermore, they are tough and wear smoothly without splintering. A 10-year service test in a university stadium has shown that hickory seat slats outperform comparable slats made from commonly used softwood lumber (fig. 13).

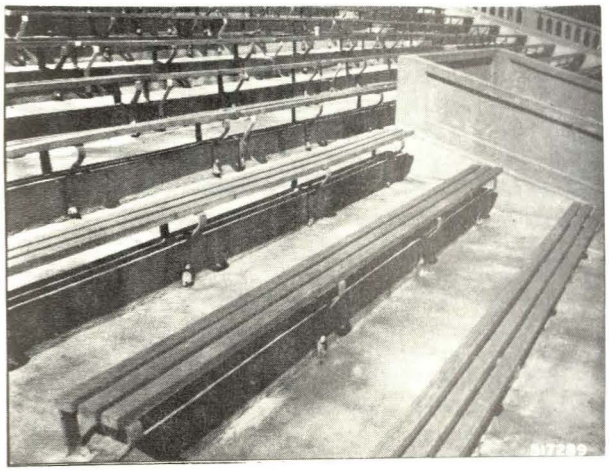


Figure 13.--*These hickory seat slats in McAndrew Stadium at Southern Illinois University outlasted softwood slats installed at the same time.*

Hickory seat slats can be produced at reasonable cost. Experimental hickory slats, made from No. 2 Common lumber, average about $1 per seat (18-in. seat width) in direct cost. We believe that this cost is low enough to allow for indirect costs and still provide a reasonable profit margin.

Slat-type seats generally consist of two 2- by 6-in., three 2- by 4-in., or three 2- by 3-in. slats fastened to metal supports anchored to a concrete or steel substructure (Sesco and Kallio 1967). Slats should be made according to the specifications for acceptable and unacceptable defects given in the Appendix, and they should be treated with a wood preservative before painting. If unpainted, they should be brush-treated biennially in-place.

## Hardwoods for Rustic Signs (Cooper 1969)

Most recreation area signs are rustic in style and made of materials selected for their beauty, utility, and availability. Usually wood or wood-based materials are used, the letters are routed, and the boards are stained or enameled. Some rustic signs have artwork. All exterior signs are subjected to sun, rain, wind, decay, insects, and vandals. Many of them must be refurbished or replaced after only 2 years.

Sign durability depends on the construction material, how the sign is made and finished, and the severity of the environment. Wood and finishes vary greatly in durability, depending on the exposure conditions, so it is important for sign manufacturers to know the exposure hazards and their effects.

Processing rustic hardwood signboards begins with the wood selection. How dry the wood is, its grade, the grain orientation, and the species characteristics must all be considered.

Slat signs should be made without knots and if possible from vertical-grain boards. Material should be seasoned to the moisture content the signs would be expected to average in service, usually 12 to 18 percent. Hardwoods should be treated with a water-repellent preservative to help prime the wood and prevent decay.

Wood properties and performance characteristics differ among and within wood species (table 4). The wood properties important to signbuilders are: (1) the ease of routing and working, (2) gluability, (3) natural durability or ease of preservative treatment, (4) finishing characteristics, (5) the occurrence of extractive stains and resins and their effect on finishes, (6) dimensional stability, and (7) resistance to checking and raised and loosened grain. Several hardwoods that we tested have been rated in each of these categories (table 4).

Signboards that do not rout easily should not be dismissed from selection. Some wood substrates that are difficult to rout without burring the edges are otherwise suitable for signboards. Basswood and soft maple sometimes do not rout cleanly, but they are relatively stable and hold finishes well. Blackgum and red oak rout fairly well, but blackgum warps and red oak face- and end-checks. The best hardwood for signs is yellow-poplar which has excellent machining characteristics and holds finishes well (fig. 14).

Table 4.--*Characteristics of tested signboard wood materials for routed, rustic, flat-grained, slat signs*

| Material | Ease of routing | Ease of working | Ease of gluing | Natural durability | Ease of treating | Finish-holding ability | Dimensional stability | Resistance to checking | Resistance to loosening of grain | Remarks | Overall rating for routed signs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cottonwood | Poor:wools up | Difficult | Easy | Very low | Moderate | Poor | Poor | Poor | Very high | Routs very poorly | Not recommended |
| Red alder | Good | Easy | Easy | Low | (1) | Good | Poor | Poor | Very high | Cups, checks | Not recommended |
| Red oak | Good | Fair | Moderate | Low | Easy | Fair | Poor | Poor | High | Excessive checking | Not recommended |
| Yellow-poplar | Excellent | Easy | Easy | Low | Difficult | Very good | Good | Good | Very high | -- | Good |
| Soft maple | Moderate | Fairly easy | Moderate | Low | Moderate | Fair to good | Fair | Poor | Moderate | -- | Fair |
| Basswood | Moderate:burrs | Easy | Easy | Low | Easy | Very good | Good | Good | Very high | -- | Fair |
| Blackgum | Poor:burrs | Difficult | Difficult | Low | Easy | Very good | Poor | Poor | Very high | Twists frequently | Not recommended |




Figure 14.--*After 4 years of exposure, this yellow-poplar sign slat is in good shape even though the water-repellent stain has eroded and exposed some bare wood. The sign can be easily refurbished to be more durable than originally. Paints and enamels last longer on yellow-poplar but are more difficult to refurbish than stains.*

How well finishes perform depends on several factors: the kind of wood used, the type of finish used, and how the finish is applied. The lighter hardwoods hold coatings longer than the dense hardwoods. Furthermore, hardwoods with fine pores hold coatings better than hardwoods that have large pores. So it is often necessary to apply a filler to large-pored hardwoods, such as oak, so coatings can bridge the pores.

If high-quality enamels with good priming are spray- or roller-applied, the recommended woods should give at least 4 years of service. Some emulsion paints will not dry quickly and may fail early in wet climates. Lacquers are brittle and fail early, and clear coatings break down sooner than pigmented coatings in sunlight. Where a rustic appearance is desired, a pigmented water-repellent stain applied to rough-sawn wood gives excellent results. It is easily applied, and after some weathering a second coat can be rolled on and will be more durable than the first. Every finish varies according to the manufacturer and should be tested and judged on its own merits on the intended substrate and in the environment where it must serve.

## SUMMARY

Recreation structures made from hardwoods have been designed, built, tested, and found very suitable for heavily used recreation areas. The heavy hardwood resists vandalism and wear and, when properly preserved, finished, and maintained, will give many years of service.

Hardwoods for outdoor structures should be air-dried to 20 percent moisture content or less before fabrication. Small knots and sound intergrown knots in the center of parts do not detract from the utility and performance of the wood, thus permitting high part yields from No. 2 Common and No. 3 Common grades of lumber. Knots and defects on edges should be avoided. Parts should be installed with the bark side up, they should be preservatively treated, and they should be finished with a penta-fortified pigmented stain.

The fast-growing demand for outdoor recreation sites and equipment is creating new opportunities for the hardwood industry. Outdoor recreation is expected to increase; and there will be a vast program of construction, expansion, and rehabilitation of facilities requiring lumber or substitute materials (Sesco 1969).

The high cost of softwood construction lumber and the superior service provided by hardwoods for many recreation structures brighten the outlook for utilization of low-grade hardwoods. It is up to the people who manage recreation areas and provide the maintenance and structures for them to seek the lower cost, more durable way. And it is the responsibility of industry to use the lower grades of lumber to advantage.

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# APPENDIX

## PURCHASING HARDWOODS

Besides the woods mentioned in the plans for each structure, several other hardwoods will serve well (table 5). Some woods, however, are not well suited for some purposes. For example, where strong, stiff members are needed, as in rafters, joists, and trusses, a soft hardwood such as cottonwood should not be used. Furthermore, a wood that is unstable with changing moisture content, such as blackgum, would be less desirable than the oaks and yellow-poplar. Soft hardwoods should not be used for flooring, but they serve well for sheathing.

In addition to selection of the species to purchase, prospective buyers must know the grade, size, and condition of their lumber. Grades are spelled out for each product, but the lower grades generally yield fewer and smaller parts. The best yields and grade use have been determined in the development of the plans, and the user will usually receive the most yield for the money from the recommended grades. A complete description of the lumber grades is available from the industry (National Hardwood Lumber Association 1974).

Hardwood is usually available at sawmills rough sawn only. A few mills also surface hardwoods, but buyers must pay extra for this service. Furthermore, hardwood lumber is seldom kiln-dried--it may be only partially air-dried or it may be thoroughly air-dried, which is most suitable for recreation products. Avoid lumber that has been kiln-dried below 12 percent moisture content; it will cost more and is too dry for outdoor use.

The purchaser of rough-sawn, air-dried lumber must have planers and surfacers to dress faces, and saws to rip to specified widths as well as to crosscut. Hardwood lumber is cut random widths and random lengths at the sawmill unless a special cutting order is made. Special cutting adds to cost and for most structures is not economical. In general, we recommend that buyers get rough-sawn, air-dried hardwoods of the recommended species and grade and then surface and saw to order in their own plants.

## ALLOWABLE DEFECTS

The following defects, which affect the grade and cost of hardwood lumber, are permissible in many products. Picnic tables, benches, and construction parts for cabins and shelters can be made using surfaced parts that have: stained sapwood; stained heartwood in 25 percent of the piece; pinholes, shotholes, and wormholes not over 1/4 in. in diameter; ordinary seasoning checks; slope of grain not exceeding 1 in 10; occasional skip 1/16 in. deep by 2 ft long; wane not over 1 in. wide and half

Table 5.--*Recommended uses for various hardwoods in recreation structures*

| Species | Structures and uses | | | | | |
|---|---|---|---|---|---|---|
| | Tables, benches, stadium seats | Siding | Sheathing | Framing, trusses | Flooring | Signs |
| American beech | | | X | | | |
| Blackgum | | | X | | | |
| Cottonwood | | | X | | | |
| Hickory | X | | | | X | |
| Maples, soft | | | X | | | X |
| Oak, red | X | X | | X | X | |
| Oak, white | X | | | X | X | |
| River birch | | | X | | | |
| Sweetgum | | | X | | | |
| Sycamore | | | X | | | |
| Yellow-poplar | | X | X | X | | X |

the length on one edge; and sound, tight knots up to 1 in. diameter on 3-in.-wide parts and 1-1/2 in. in diameter on wider parts providing the knots are not on the edges.

Pith, shake, or raised grain, rot, and open bark pockets should not be permitted in the planks. Table legs should be free of pith, shake, and rot; but the following defects may be permitted: wane up to 1 in. wide on any face, and full length; intergrown or tight knots up to 1 in. in diameter; pinholes, shotholes, and spot wormholes; other holes up to 1/4 in. in diameter; and burls, stain, streak, and season checks.

The following specifications for hickory stadium seat slats incorporate the results of several tests (Micklewright 1960).

Unacceptable defects are: splits; knot holes and other holes that extend through the slat or show on the top face; rot; exposed pith; bark pockets larger than 1-1/4 in. on the top face and edges or 1/2 in. deep on any face; wane wider than 1/4 in. on any face; shake; grain slope in excess of 1 in. in 10 in. parallel to the length of the slat; and end-checks deeper than 3/8 in.

Acceptable defects are: burls; stains; streaks; spot; pin wormholes; ordinary seasoning checks; wane up to 1/4 in. wide; bird peck; minor planing skips; torn grain no deeper than 1/16 in. on the bottom face or edges; and any other sound defects that do not reduce strength; sound, tight, intergrown knots up to 1-1/4 in. in diameter and knot clusters up to 2 in. in diameter, except that maximum-size knots should not be closer than 12 in., center to center, within a slat; and any warp (cup, crook, bow, and twist) that can be eliminated by clamping the slat in place during installation.

## PRESERVATION AND FINISHING

All the products described must be protected from insect damage and decay. Structures in contact with the soil and subjected to alternate wetting and drying are most susceptible. Damage can be prevented by treating with a 5-percent solution of water-repellent pentachlorophenol in light oil or mineral spirits. The pentachlorophenol is toxic to wood-destroying insects and decay organisms, and the addition of paraffins for water repellency greatly reduces the effects of weathering. When wood is properly treated, it is entirely safe for contact by humans and animals.

Treatment methods are simple. Once the wood parts are air-dried and completely fabricated, they can be dipped or soaked in a 5-percent solution of water-repellent pentachlorophenol in light oil as specified below:

| *Part* | *Time* |
|---|---|
| Picnic tables: | |
| Tops, seats | 8 hr |
| Legs | 24 hr |
| Children's tables | 5 min |
| Movable benches: | |
| Seats, backs | 5 min |
| Legs | 24 hr |
| Stationary benches | 8 hr |
| Picnic shelter: | |
| Studs, columns | 24 hr |
| Rustic cabin: | |
| Rigid-frame columns, joists, griders, plates | 24 hr |
| Other framing | 8 hr |
| Siding, trim | 5 min |
| Stadium seats | 8 hr |
| Signs | 5 min |

Parts in contact with ground receive long treatment; parts above ground and parts to be sat on need not be treated so long. A tank large enough to submerge the part is all that is necessary. The preservative need not be heated or applied under pressure. Brush away any crystalline deposits on the surface of parts after the preservative dries. Table and bench surfaces are usually safe for contact after treated parts have been exposed to the weather for 30 days. During and immediately after treatment, the wet preservative may cause some skin irritation. The manufacturer's precautions should be followed.

After the preservative has dried, most recreation structures should be finished. Usually a rustic brown or other natural wood color is desirable. The most practical finish is a penta-fortified natural stain that will not peel or flake because it does not form a film. It penetrates the wood and will fade or erode with time, but it is easily refurbished with a light roller application. Such stains can be purchased or homemade (USDA Forest Products Laboratory 1955).

Cooper, Glenn A., and Cleo Caraway.
1975. Build recreation structures from low-grade hardwoods. North Cent. For. Exp. Stn., St. Paul, Minn. 21 p., illus. (USDA For. Serv. Gen. Tech. Rep. NC-14)

A collection of plans; instructions for assembly, preservation and finishing; and general information on the use of hardwoods for picnic tables, benches, stadium seats, shelters, cabins, and signs.

OXFORD: 836:833:176.1--081.3. KEY WORDS: picnic tables, cabins, shelters, red oak, hickory.

Cooper, Glenn A., and Cleo Caraway.
1975. Build recreation structures from low-grade hardwoods. North Cent. For. Exp. Stn., St. Paul, Minn. 21 p., illus. (USDA For. Serv. Gen. Tech. Rep. NC-14)

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Birds, animals and flowers are dying to tell us...no pollution, please!